AN

ASTRONOMICAL

INTRODUCTION

TO THE

STUDY of *GEOGRAPHY*.

PRINCIPALLY INTENDED

FOR THE USE OF SCHOOLS.

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PREFACE.

THERE is no one part of literature that comes into more frequent uſe than Geography; independant of it's claim upon our attention, as an elegant, and highly entertaining ſcience, that opens the mind, and enlightens the underſtanding; it is, as it were, the key that gives us acceſs to every other branch of human knowledge, moſt of which would, without it's inſtrumentality, be either totally hidden from us; or, at beſt, known very partially and ſuperficially.

Hiſtory, which has been well ſtiled, Philoſophy teaching by Example. Hiſtory! which is a faithful and intereſting picture of human manners, tranſmitted from age to age,

for the ſucceſſive improvement of mankind, leans, at every ſtep, on this ſubſervient handmaid. Commerce and Navigation, thoſe important links in the chain of civil ſociety, abſolutely depend on Geography for their very exiſtence. Natural Hiſtory, or, the knowledge of the animal, vegetable, and mineral kingdoms, is only to be ſucceſsfully cultivated, or it's diſcoveries perpetuated, to any good purpoſe, by a minute knowledge of the general ſtructure, and particular diviſions, of the planet we inhabit. Even converſation becomes low and illiterate, among perſons ignorant of this neceſſary mean, to underſtand the common occurrences of the day. And, finally, without a very competent idea of it, the ſyſtems of policy, morali y, and religion, are an unintelligible jargon of words.

Though

Though the accurate and ſkilful geographer muſt be likewiſe a perfect maſter of it's ſiſter ſcience Aſtronomy; yet a ſlight and general knowledge of this laſt, will, without engroſſing the time requiſite for other ſtudies, or demanding too ſerious and ſevere application, enable the young ſtudent to attain to ſuch a degree of perfection in the former, as may be ſufficient to anſwer all the common purpoſes of life.

As Aſtronomy is ſtudied, and attained to, by the viſual obſervation of diſtant luminous bodies, optics, or the doctrine of light and colours, together with the nature of viſion; that is to ſay, the manner and laws by which the organs of ſight convey ideas to the mind, requires a ſlight previous explication.

The rays of light then, are ſtreams of inconceivably minute particles of all the primary colours, iſſuing in direct lines, and with extreme velocity, from certain bodies, we therefore call luminous.

A due mixture of all theſe rays makes white, a total want, or privation of them, makes black, and the different particles of different bodies, reflecting ſome rays of a certain colour, and imbibing, or abſorbing thoſe of all other colours, occaſions thoſe differences of colour obſervable in various bodies, *viz.* red, green, yellow, purple, &c.

A ſingle ray of light being made up of theſe ſeveral colours, if ſuffered to enter a darkened chamber, may be broken into its component parts, by cauſing it to paſs through a ſolid triangular glaſs called a Priſm; and then

then its figure on the wall, or a white ſkreen, which before was round, becomes oblong, and coloured, in the following order, from the loweſt upwards; red, orange, yellow, green, blue, purple, and violet.

The rays of light, it has been already obſerved, move in ſtraight lines, and when they fall on an oppoſing body, are either tranſmitted, reflected, or abſorbed, as the body happens to be tranſparent, reflecting, or opake. When they fall upon the eye they paſs through the ſeveral coats and humours of which it is compoſed, till, at it's very bottom, they ſtrike on a very fine netted ſubſtance, called the Retina, on which a true and delicate, but inverted picture, of whatever object they flow from, is inſtantly formed: this picture is abſolutely neceſſary to viſion; though how it is communicated

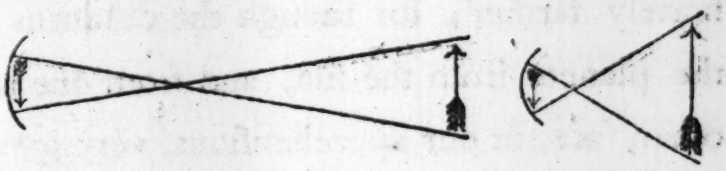
through

through the optic nerve to the intellect, or why the inverted picture forms to the mind an upright image, is not yet exactly aſcertained among philoſophers.

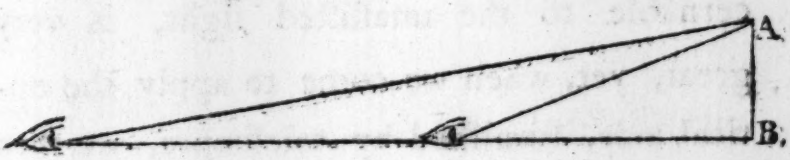
The eye, by the ſenſe of ſeeing, repreſents to the mind the colour, extent of ſurface, and figure, or termination of bodies, likewiſe their motion, when it is in ſuch a direction as to cauſe a change of the image's place upon the retina: but when a body moves directly from, or directly towards the eye of the obſerver, then, as the picture continues unmoved upon the retina, the motion is only judged of by the mind, from the change of the apparent dimenſions of the ſurface, and of its colour and diſtinctneſs of outline; which always vary in a certain degree, as the body recedes from, or approaches the place of the ſpectator.

It

It is principally from this law of viſion, that the diſtances of the heavenly bodies are aſcertained; for lines drawn from the eye to the top and bottom of the object determine it's ſize; and as theſe lines are cloſer or wider, thus,



the body is ſaid to be larger or ſmaller, and to ſubtend a greater or leſſer angle; from whence we readily apprehend, that at different diſtances from the eye, the ſame body will appear very different in reſpect of ſize, as thus,



where it is obvious the angles, and therefore the apparent magnitude of the line *A B* increaſes as the eye approaches.

The utility of Aſtronomy to the ſtudy of Geography, is circumſcribed by the bounds of the ſolar ſyſtem; which means, that ſet of planets that reſpect our luminary of day as their common centre of gravitation. But the ſcience at large extends, I may ſay, infinitely farther; for though the diſtances of the planets from the ſun, and from one another, are, in our apprehenſions, very great, extending to many millions of our miles, yet theſe diſtances vaniſh, and the whole aſſembly of the ſun, the planets, and their moons, is crowded into a ſingle point, when we obſerve them from the neareſt fixed ſtar. Though the number of ſtars, diſcernable to the unaſſiſted ſight, is very great, yet, when we come to apply the optical aids, furniſhed by teleſcopes, we then indeed diſcover an innumerable hoſt of blazing luminaries, which, by their different degrees

grees of brilliancy, and of apparent ſize, we can readily judge are ſcattered at very unequal diſtances through the ample fields of ſpace.

Thus the face of heaven, which exhibits to the unlettered ſpectator only a concave vault, beautifully ſtudded with liquid jems, affords the aſtronomic eye a glimpſe of new worlds, and opens ſuch an amazing ſcene of infinite power and wiſdom, that the mind, loſt in contemplation, inſtantly recurs to the author, and repoſes it's feeble ſpeculations in the boſom of Omnipotence.

On this ample theatre we behold the Deity diſplaying, on a ſtupendous and magnificent ſcale, the ſame infinity of attributes, that equally, though in the oppoſite extreme, excites our aſtoniſhment in the contrivance

trivance and organization of thoſe animated atoms, only diſcoverable by a different application of the ſame optical aſſiſtances, that before enabled us to penetrate the tractleſs regions of ſpace. Hence we learn the true value of ſcience and philoſophy. They ever lead to the moſt devout and worthy notions of the Deity, whether we conſider him in his minuteſt works, or carrying up our ideas to thoſe boundleſs diſplays of his power manifeſted in the creation and government of unnumbered worlds, there contemplate the Almighty and Omnipreſent Being—"Whom "the heaven of heavens cannot contain."

I.

The ſpacious firmament on high,
With all the blue æthereal ſky,
And ſpangled heav'ns, a ſhining frame,
Their great original proclaim:

Th'

Th' unwearied ſun, from day to day,
Does his Creator's power diſplay,
And publiſhes to every land,
The work of an Almighty hand.

II.

Soon as the ev'ning ſhades prevail,
The moon takes up the wond'rous tale,
And nightly to the liſt'ning earth,
Repeats the ſtory of her birth:
Whilſt all the ſtars that round her burn,
And all the planets, in their turn,
Confirm the tidings as they roll,
And ſpread the truth, from pole to pole.

III.

What tho' in ſolemn ſilence all,
Move round the dark terreſtrial ball,
What tho' nor real voice nor ſound,
Amid their radiant orbs be found?
In Reaſon's ear they all rejoice,
And utter forth a glorious voice,
For ever ſinging as they ſhine,
The hand that made us is divine.

Note. As this little tract is intended to communicate only ſo much of the ſublime ſcience of aſtronomy as the author deems abſolutely neceſſary to a moderate, but rational knowledge of geography, it is deſignedly brief, and, in a certain degree, ſuperficial. It's form, which is that of queſtion and anſwer, will apologize for theſe and other defects, as it implies, that it is to be ſtudied with the aſſiſtance of a tutor, who is reaſonably inſtructed in the matters it treats of. As an introduction to the ſcience of aſtronomy, it may be conſidered as a ſyllabus, or heads of lectures, to aſſiſt the memory of the teacher, and to excite the curioſity, and direct the ſtudies of the ſcholar, and laſtly, as it ſuppoſes both to have acceſs to the globes, and alſo to ſome of the various and excellent atlaſſes, or ſyſtems of geography, publiſhed in our own or other modern languages, it was thought unneceſſary to increaſe it's bulk, or ſeeming conſequence, by plates and references, which are to be found in great abundance, in any of the above-mentioned works.

Aſtronomical

A N

Aſtronomical Introduction, &c.

CHAPTER I.

Of the Solar Syſtem.

Q. WHAT is meant by the Solar Syſtem?

A. A certain number of primary and ſecondary planets, regarding the Sun as the center of their motions, and revolving round it in different lengths of time, making a part of the univerſe.

Q. What do you mean by the Univerſe?

A. A vaſt number of ſuns, attended by worlds unknown to us, that the Almighty Creator has been pleaſed to call into exiſtence.

Q. Can we diſcover any other ſuns?

A. Yes. We have all the reaſon in the world to ſuppoſe, that each of the fixed ſtars, that beſpangle the Heaven, is a Sun to a ſyſtem, or aſſembly of planets.

Q. Of how many bodies does the Solar Syſtem conſiſt?

A. Of the Sun, as centre and fountain of light, of ſeven primary, and fourteen ſecondary planets, beſides comets, whoſe numbers are unknown.

Q. What are the primary Planets?

A. Planets that conſider the Sun alone as the center of their motions.

Q. What are ſecondaries?

A. They are attendants on primary ones, conſidering their primaries as the centre of their motions, though carried along with them round the Sun; they are called Moons, or Satellites.

Q. Name the primary planets in their order?

A. Neareſt the Sun is Mercury, then Venus, the Earth, Mars, Jupiter, Saturn, ſurrounded with an extraordinary luminous ring, and far the moſt remote the Herſchel, Georgian Planet, or Uranos, as called by ſome.

Q. How many of theſe primary planets have moons, or attendants?

A. Four that we know of, the Earth one, Jupiter four, Saturn ſeven, and Herſchel two.

Q. How

Q. How are the planets ſituated?

A. At different diſtances from the ſun, making their annual revolutions in times proportioned to their reſpective diſtances.

Q. What do you mean by times proportioned to their reſpective diſtances?

A. I mean, that the moſt remote planets take longer, and the nearer ones ſhorter portions of time, to perform their reſpective revolutions.

Q. What is the track, or courſe, deſcribed by a planet in the heavens called?

A. The orbit; the paſſage through which completes it's year, and brings round the intire ſucceſſion of it's ſeaſons.

Q. What is it's revolution on it's axle, or poles, called?

A. It's natural day: and this rotation occaſions it's ſucceſſions of light and darkneſs.

Q. How is it known, that the earth revolves, or turns, on it's axle.

A. By the regular ſucceſſions of day and night.

Q. How is it known that the other planets revolve on their axles.

A. By obſerving ſpots on their ſurfaces diſappear and return at ſtated intervals.

Q. Are their natural days of the ſame length with ours?

A. No: their days all differ in length from ours, and from each other's.

Q. Does the ſun revolve on his own axle?

A. He does, in about twenty-ſix days.

Q. What retains the planets in their orbits —?

A. A law of Nature called Gravitation.

Q. What is meant by Gravitation?

A. That force wherewith bodies ſtrive to approach each other; and as all material ſubſtances are thus attracted, they muſt tend to a common point of union, which point is called the Centre of Gravity.

Q. Doth this law obtain on earth?

A. It does: it is by this law that heavy bodies deſcend through the air, and plumb lines all hang downwards from the point of ſuſpenſion.

Q. As this law makes all bodies tend to the earth, why do not the planets and earth, tending to the ſun, *their* common centre of gravity, fall together to it?

A. Becauſe

A. Becauſe the Creator originally impreſſed them with another force, impelling them in a right line, and this force acting in a direction different from that of gravity, the combination of the two, occaſions them to move perpetually round the centre of gravitation.

Q. What is the reaſon that their motions, like thoſe of bodies on earth, do not become perpetually ſlower, till they finally ſtop?

A. Becauſe the region in which they move is pure ſpace, and void of reſiſting ſubſtances; but on earth, the reſiſtance of air, water, the rubbing of moving bodies againſt the ſurface of the ground, &c. &c. gradually retard, and finally put a ſtop to all motions.

Q. What are Comets?

A. Planets moving in very oblong orbits, extremely quick when near the ſun, and very ſlow when remote from it: when near the ſun they are uſually accompanied by a ſhining train of light.

Q. How are Planets known from fixed Stars?

A. By their change of place in the heavens, appearing now near certain fixed ſtars, then paſſing

theſe by, and approaching others, till they complete their intire revolution.

Q. Why are fixed Stars ſo called?

A. Becauſe they remain at reſt, and always preſerve their relative diſtances from each other.

Q. How are the fixed Stars diſtinguiſhed?

A. Some by particular names, others by that of the conſtellation to which they belong.

Q. What is a Conſtellation?

A. A number of ſtars, ſuppoſed to be included in an imaginary figure.

Q. Which are the moſt remarkable of theſe?

A. The Conſtellations, called the Signs of the Zodiac; becauſe through them the planets all revolve round the ſun, and through them the ſun appears to move annually.

Q. What does the word Zodiac mean?

A. It is derived from a Greek word that ſignifies living; and the ſtars in theſe ſigns are called Zodiacal Stars, as moſt of the imaginary figures that include them repreſent living creatures.

Q. What is the ſun's apparent path among theſe called?

A. The

A. The Ecliptic, and the conſtellations it paſſes through the twelve ſigns, *viz.* Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagitarius, Capricornus, Aquarius, Piſces.

Q. How do the ſeaſons correſpond with theſe in our hemiſphere?

A. The ſun enters Aries at the vernal æquinox, Cancer at Midſummer, Libra at the autumnal æquinox, and Capricorn at Midwinter.

Q. Which are the chief northern conſtellations?

A. The two Bears, (in the tail of the leſſer of which is the Pole, or Axle, round which the ſtars ſeem to revolve in twenty-four hours) Caſſiopea, Andromeda, Pegaſus, Hercules, Perſeus, the Swan, the North Crown, the Lyre, the Eagle, &c.

CHAP.

CHAP. II.

Of the Earth.

Q. WHAT is Geography?

A. It is the ſcience that treats of the ſituation, figure, motions, and places of the planet we inhabit.

Q. Whence is Geography derived?

A. From two Greek words, that ſignify a treatiſe on the earth.

Q. What is the figure of the earth?

A. A flatted ſphere like an orange, it's axle, or poles, paſſing through the ſhorteſt diameter.

Q. Deſcribe the earth and it's ſurface generally.

A. It is a globe compoſed of land and water (terraqueous) caſting a ſhadow (opake) moving according to certain laws through ſpace, and by it's motions affording a ſucceſſion of day and night, and of the different ſeaſons, to it's inhabitants; it's ſurface

face is diverſified with every variety of land and water, exhibiting in ſome parts great extent of ocean without land; in others, iſlands, or lands quite ſurrounded by water.—Here, large continents and peninſulas, indented by bays; watered by lakes, navigable rivers, and ſmaller ſtreams; now contracting into narrow iſthmuſes; then extending in fertile plains, and again riſing in ſwelling hills: there, rocky and deſolate regions, projecting their towering promontories into the deep, and riſing from the ſhore in lofty and ſnow-topped mountains.

Q. How do you prove that the earth is ſpherical?

A. From the teſtimony of circumnavigators, who have found it to be ſo.

Q. How many motions has the earth?

A. Two principally, one round it's own axle, or poles, the other round the ſun in the path called the ecliptic.

Q. What are the Poles of a Sphere?

A. Certain points in it's circumference directly oppoſite to each other.

Q. What is the diſtinguiſhing property of the Poles of a Sphere?

A. That

A. That the Sphere revolves round them, and when all it's other parts are in motion it's poles are at reſt.

Q. What is the Earth's motion on it's axle, or poles, called?

A. It's diurnal motion; it is performed in twenty-four hours, making the ſucceſſion of day and night.

Q. While the Earth revolves round the Sun, how many revolutions does it make on it's own axle.

A. About three hundred and ſixty-five and a quarter of a one.

Q. Whence ariſes the ſucceſſion of ſeaſons?

A. From the motion round the ſun, and that round it's axle, not being performed in the ſame plane, in conſequence whereof the ſun ſhining on the ſame place more directly at one time of year, and more obliquely at another, occaſions different degrees of heat and cold, and of courſe different ſeaſons.

Q. What are the opinions of philoſophers, endeavouring to account for theſe appearances called?

A. Theories,

A. Theories or Syſtems, the principal of which are the Copernican and Ptolemaic Syſtems.

Q. What is the Ptolemaic Syſtem?

A. The Ptolemaic Syſtem ſuppoſes the Earth fixed in the centre, and that the Sun moves through the ſigns of the Ecliptic in a year, and the ſtarry heavens revolve round the poles in twenty-four hours; this Syſtem owes it's name to the celebrated aſtronomer and geographer Ptolemy, who flouriſhed about one hundred and forty years after the birth of Chriſt.

Q. Is this a true account of the heavenly motions?

A. No: it is diſproved, and confuted by invincible arguments.

Q. How came it to be received?

A. From ſuperficial obſervations and popular prejudices; becauſe, as the apparent motions are ſuch as it deſcribes, it was adopted without ſufficient inquiry.

Q. What is the Copernican Scheme?

A. The Copernican Scheme ſuppoſes the Sun in the centre, and that the planets revolve around

it, having, at the ſame time, a rotatory motion on their reſpective axles; it was diſcovered originally by Pythagoras, or his ſcholar Philolaus, and revived by Copernicus, who was born at Thorn in Pruſſia, A. D. 1472.

Q. Is the truth of the Copernican Syſtem univerſally admitted?

A. It is. Sir Iſaac Newton, by inveſtigating it's laws, and reconciling it's appearances to thoſe of gravity, has put the truth of it beyond the poſſibility of a doubt.

CHAP. III.

Of the Centre of the Sphere.

Q. HOW is the general ſituation of places on the earth determined?

A. By their poſition with reſpect to ſome one of the Circles of the Sphere.

Q. What do you mean by the Circles of the Sphere?

A. I mean certain imaginary Circles ſuppoſed to ſurround the Globe, the planes of which being extended to the ſtarry heavens, mark in them exactly correſponding ones.

Q. What is the moſt general diviſion of theſe Circles?

A. They are divided generally into greater and leſſer Circles.

Q. Where are the Poles of a great Circle found?

A. In the ſurface of the Sphere, at an equal diſtance from all points of the Circle, and of courſe 90° from it's circumference.

Q. What are great Circles?

A. All Circles deſcribed on the ſurface of the Sphere, whoſe centre is the centre of the Sphere; they have, therefore, a common centre, and each divides the Globe into two half Globes, or Hemiſpheres.*

Q. Why are they called great Circles?

A. Becauſe they are the largeſt that can be deſcribed on a Sphere, and theſe, when they croſs, always equally divide each other.

Q. Which are the chief of the great Circles?

A. The Æquator, the Ecliptic, the Horizon, the Meridians, and the Vertical Circles.

Q. What is the Æquator?

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* It will likewiſe appear in chapter IV. that the circumference of all circles, great and ſmall, is conſidered as being divided into 360 equal parts, called degrees.

Q. It

A. It is a great Circle dividing the Sphere into the northern and ſouthern Hemiſpheres, it's poles are likewiſe the poles of the Earth.

Q. What is the Ecliptic?

A. A great Circle cutting the Æquator at an angle of about 23° 28′, it marks the apparent annual revolution of the Sun.

Q. What is the Horizon?

A. A great Circle dividing the viſible from the inviſible Hemiſphere.

Q. Where are the Poles of the Horizon found?

A. In the points immediately above our heads, and beneath our feet, called the Zenith and Nadir.

Q. What is the Meridian of a place?

A. A great Circle paſſing through the Poles of both the Æquator and the Horizon, and dividing the Sphere into the eaſtern and weſtern Hemiſpheres.

Q. What are the vertical Circles?

A. Great Circles paſſing through the Poles of the Horizon, and cutting the Horizon in all it's points: theſe Circles are alſo called Azimuths.

Q. Which is the moſt remarkable of theſe?

A. The one which paſſes through the eaſt and

weſt points of the Horizon, 90° from the Meridian, and is called the Prime Vertical.

Q. How do you define a leſſer Circle?

A. It is a Circle whoſe centre is not in the centre of the Sphere, and therefore cutting the Sphere unequally.

Q. Which are the principal of theſe?

A. The circles called Parellels of Latirude and Altitude.

Q. What are Parallels of Latitude?

A. Leſſer Circles parallel to the Æquaror.

Q. Which are the moſt remarkable of theſe?

A. The Tropics and polar Circles.

Q. What are the Tropics?

A. Two leſſer Circles, one on each ſide of the Æquator, touching the Ecliptic at it's greateſt diſtance from the Æquator.

Q. Why are they called Tropics?

A. From a Greek word, which ſignifies to turn; becauſe, when the Sun arrives at either of them, he ſeems to return to the Æquator.

Q. When is the Sun at the Tropics?

A. At Midſummer and Midwinter, making the longeſt

longeſt and ſhorteſt days of the year, under an oblique Sphere.

Q. What are the polar Circles?

A. Leſſer Circles, at the ſame diſtance from the Poles that the Tropics are from the Æquator.

Q. How are they diſtinguiſhed?

A. The northern polar Circle is called the Arctic, from the Greek name of a Bear, as theſe Conſtellations are within the northern polar Circle, and the ſouthern the Antarctic, or oppoſite to the Arctic.

Q. What are the Parallels of Altitude?

A. Leſſer Circles parallel to the Horizon, determining the heigth of any heavenly body above it.

Q. What are the Poles of a great Circle?

A. Certain points in the ſurface of the Sphere 90° diſtant from all parts of the circumference of the Circle.

CHAP. IV.

Of the Situation of Places with Reſpect to the Circles of the Sphere.

Q. HOW are the Circles of the Sphere divided?

A. Into degrees and parts of degrees.

Q. How much is a Degree?

A. The three hundred and ſixtieth part of the circumference of a circle, and therefore the greateſt and leaſt circles contain an equal number of degrees, viz. 360.

Q. What is a Quadrant?

A. Ninety degrees, or the forth part of the circumference of a circle, or the meaſure of right angle.

Q. What is meant by the meaſure of an angle?

A. Any two lines drawn from the centre to the circumference

circumference of a circle, include a part of the circumference between them, and the number of degrees, and parts of degrees, in this included portion, is the meaſure of the angle made by the two lines at the centre.

Q. What are the parts of degrees?

A. Minutes and ſeconds, 60′ minutes make a degree, and 60″ ſeconds a minute.

Q. What is the ſituation of places, with reſpect to the Æquator, called?

A. Their latitude, which is either north or ſouth, as counted towards the north or ſouth Pole.

Q. To a perſon at the Æquator, how is the Pole of the world ſituated?

A. The Pole of the Æquator being the Pole of the world, and the Æquator itſelf being in the Zenith*, it's Pole, that is to ſay, the Pole of the

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* For the ſuppoſed place of every ſpectator is in it's own Zenith, as the Zenith and Nadir are the points immediately above the head and beneath the feet of the ſpectator.

world muſt be 90 degrees from the Zenith, or in the Horizon.

Q. If you leave the Æquator, and go towards either Pole, how will the Poles be then ſituated?

A. If you go one degree northwards, the point of the Æquator, that was the former place of the obſerver, will then become one degree ſouth of your Zenith, or 91° from your northern Horizon, and therefore that is the Æquator's Pole. The Pole, which is 90° from the Æquator, one degree above the northern Horizon, the Æquator in like manner being 89°, becauſe from the Horizon through the Zenith to the oppoſite Horizon, is 180°, and 91 and 89=180 from your ſouthern Horizon, and it's Pole 90° from it's itſelf, will be one degree below the ſouth Horizon: thus, if you increaſe your diſtance from the Æquator, you equally increaſe the diſtance of that Pole of the Æquator towards which you go from the Horizon, and of courſe ſink the Æquator towards the oppoſite Horizon; and as the diſtance from the Æquator towards the Pole is the Latitude, it follows, that the Pole of the ſame denomination with the Latitude is always elevated

vated above the Horizon by a number of degrees and parts of degrees, equal to the diſtance of the given place from the Æquator; that is to ſay, the elevation of the Pole, or it's diſtance from it's neareſt Horizon, is equal to the Latitude of the place.

Q. Recite the names and general properties of the Æquator?

A. It divides the Globe into the northern and ſouthern Hemiſpheres, whence it is called the Æquator, when, at the vernal and autumnal equinoxes, the Sun arrives at it, all the different parts of the world enjoy equal day and night: for which reaſon it is called the Æquinoctial Circle; and as Latitude is counted from it towards each Pole, ſailors call it "the Line," as being the moſt uſeful and important one in navigation.

Q. What are the ſituations of places with reſpect to the Horizon?

A. Their bearings; theſe are determined by the part of the Horizon they cut, or bear upon.

Q. How is the Horizon divided?

A. Into the 32 points of the compaſs.

A. Which

Q. Which are the moſt remarkable?

A. The four called the Cardinal Points, viz. Eaſt, Weſt, North, South.

Q. How are theſe points determined?

A. Either by the Mariner's Compaſs, that points towards the north, or by obſervation of the heavenly bodies.

Q. Are theſe obſervations eaſily made?

A. Very eaſily. If at night you look at the ſtar in the tail of the leſſer Bear, you look north, the eaſt on your right hand; if in north Latitude, and north of the Tropic, you obſerve the Sun at noon, you look ſouth, and the weſt is on the right hand.

Q. Recite the general properties of the Horizon?

A. It is a Circle continually ſhifting with the place of the obſerver, as it's Poles are always found in the Zenith and Nadir; the virticles Circles paſs through it's Poles, and cut it in the points of the compaſs; the diſtance of any heavenly body from it, counted on one of theſe, is called it's Altitude, it's diſtance in like manner below it, it's Depreſſion; and

and finally, it divides the viſible from the inviſible Hemiſphere.

Q. What is the ſituation of places with reſpect to any given Meridian called?

A. Their Longitude, which is either eaſt or weſt, as the place lies to the eaſt or weſt of the firſt * Meridian.

Q. How is Longitude reckoned?

A. Either in degrees and parts of the Æquator and it's parellels, or in time.

Q. Why in time?

A. Becauſe as the Æquator, and all it's parallels, revolve in twenty-four hours, 15° will paſs an univerſal Meridian, or a great circle drawn through the Sun and the poles of the Earth in one hour, 30° in two hours, and ſo on, till the whole Æquator paſſes; therefore a place 15° eaſt of another is ſaid to be one hour eaſt, and a place 30° weſt is called two hours weſt, and ſo on.

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* The firſt Meridian is that Meridian from whence you begin to reckon, as for inſtance, the Meridian of London, Paris, &c.

Q. Is

Q. Is the Longitude of places as eaſily and certainly determined as their Latitude?

A. By no means; but the modern improvements in Aſtronomy and Mechanics, have rendered the determination of the Longitude much eaſier, and more certain, than it formerly was.

CHAP. V.

Of artificial Globes and Maps.

Q. WHAT are the chief helps to the ſtudy of Aſtronomy and Geography?

A. Artificial Globes and Spheres, repreſenting the face of the ſtarry Heavens and of the Earth.

Q. How do theſe facilitate the above-mentioned ſtudies?

A. By repreſenting the imaginary Circles of the Sphere, they aſſiſt the imagination to conceive how they are really ſituated, and by a delineation of the ſurface of the Earth and the face of the Heavens, they enable you to fix them ſeverally in the memory, and to ſee at one view, by theſe miniature repreſentations, the poſition of each part, with reſpect to the other, and to the whole.

Q. How many kinds of artificial Globes are in uſe?

A. Two; one the Celeſtial the other the Terreſtrial Globe.

Q. What is the Celeſtial Globe?

A. A Globe on which the great circles of the Heavens are delineated, the Stars and Conſtellations depicted, and the Sun's place in the Ecliptic marked for the ſeveral days of the year; it is furniſhed with an Horizon, a magnetic Needle and Card, an artificial Sun and Moon, and a Quadrant of Altitude, with a contrivance to faſten it in the Zenith, to repreſent a vertical Circle, and laſtly an hour Circle, with an Index, to point to the time required?

Q. To form a juſt idea of the face of the ſky, from the inſpection of the Celeſtial Globe, what s required?

A. To conceive it conſiderably large and tranſparent, and the ſpectator placed within at the centre.

Q. What is the Terreſtrial Globe?

A. An artificial Globe, repreſenting the ſurface of the Earth; it is marked with thoſe circles that the

Earth

Earth has in common with the Heavens, and moreover with twenty-four Meridians, to denote the Longitudes of places, and is alſo provided with the above recited furniture of the Celeſtial Globe.

Q. What is the uſe of the Compaſs that is attached to each Globe?

A. It is of uſe in aſſiſting you to rectify them.

Q. What do you mean by rectifying the Globe, or any other inſtrument uſed in aſtronomical or geographical Problems.

A. I mean, adjuſting it's ſituation and parts in ſuch a manner, as to render it fit for ſolving the propoſed Queſtion, or Problem?

Q. What is a Problem?

A. Something required to be done.

Q. How are the Circles on artificial Globes divided and marked?

A. On both Globes the Æquator is divided into degrees and minutes of Longitude on the Terreſtrial, and of right aſcenſion, or diſtance, from the vernal interſection of the Æquator and Ecliptic on the Celeſtial, and alſo into hours and minutes of time on each. The Horizon is divided into the

points of the compaſs, and their degrees are marked with the ſigns of the Zodiac, and the Sun's place in the Ecliptic, for each day of the year. The Meridian is marked with the degrees and parts of degrees, which on the celeſtial Globe count the declination from the Æquator, and on the Terreſtrial the Latitudes of places; and the Ecliptic is on each divided into ſigns, degrees, and parts of degrees, and laſtly, the Quadrant of Altitude into degrees and parts of degrees.

Q. What are Maps?

A. Delineations on a flat ſurface of the Earth, and it's different regions.

Q. How much of the Earth can be repreſented in one Map?

A. A Hemiſphere; for you can only ſee half a Globe at once.

Q. What is the art of making theſe delineations called?

A. It is called Perſpective; by it one half of the Globe can be drawn on a flat circle, repreſenting the plane of any of the great circles; for as the great circles all reach to the very circumference of the

the Sphere, if you ſuppoſe the Sphere tranſparent, and the eye placed at a due diſtance, it is evident that all the lines and figures of one half of the Globe may be traced on the plane* of that great circle, oppoſite to the centre of which the ſpectator is placed; but a moment's conſideration will ſhew, that the parts of theſe muſt not be at the reſpective diſtances on the flat that they were on the round ſurface. Theſe perſpective views are called Projections of the Sphere on the plane of the Æquator, the Horizon, the Meridian, &c. &c.

Q. How are leſſer portions of the Earth repreſented?

A. In Maps of kingdoms, countries, provinces, counties, &c. laid down in various ways, according to the ſkill or taſte of the artiſt.

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* The plane of a great circle, is an imaginary plane paſſing exactly through all parts of the circumference, and through the centre of the circle.

CHAP. VI.

Of Problems on the Globes.

1.

Q. HOW do you rectify either Globe?

A. By the help of the Compaſs, which has now about 24° and a half of weſterly variation, or by a Meridian Line. Place the brazen Meridian in the plane of the true Meridian, and elevate the Pole of the ſame name with the Latitude above the artificial Horizon, by a number of degrees and minutes, equal to the Latitude of the real or ſuppoſed place of the obſerver.

Q. How do you repreſent the Sun's ſituation in the heavens for any day at noon?

A. Rectify the Globe, find the Sun's place for the given day at noon on the artificial Horizon, and

and bring the Sun's centre to the ſame ſign, degree, and minute of the Ecliptic.

2.

Q. How do you find the hour and minute of the Sun's riſing and ſetting on any given day, for a certain Latitude?

A. Having found the Sun's place as before, bring it's centre to the brazen Meridian, and fix the hour index to twelve hours, then, by turning the Globe eaſtward, till the Sun's centre is at the Horizon, the index will point to the hour and minute of ſun-riſe; and in like manner, if you bring the Sun's centre to the weſtern Horizon, it will ſhew the hour and minute of ſun-ſet.*

3.

Q. How do you find the length of the day and night by the Celeſtial Globe for any place or ſeaſon?

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* The different conſtruction of Globes makes a little variety in the manner of ſolving ſome of theſe Problems, which will be beſt explained by having recourſe to the Globe itſelf that is uſed.

A. Find

A. Find the Sun's place as before, and the Globe being carefully adjuſted for the Latitude, bring the Sun's centre to the eaſtern Horizon, then obſerve at what hour and minute the hour index points, turn the Globe gently till the Sun's centre is found in the weſtern Horizon, count the number of hours and minutes gone over by the index, this gives the length of the day, and it's complement to twenty-four hours, the length of the night as required.

4.

Q. How do you find the time that the moon, or any ſtar, or planet riſes, ſets, and comes to the Meridian at any given day and latitude?

A. Find, in ſome aſtronomical almanack, the Moon, &c's place in the Ecliptic, or the Heavens, for the hour and minute given, then mark that ſpot on the Globe; having brought the Sun's place for the ſame time to the Meridian, and ſet the index to twelve o'clock, by bringing the mark either to the Meridian or to the eaſtern or weſtern Horizon, (turning the Globe on it's axis) the hour index will in turn ſhew the hour and minute of the ſouthing or appulſe to the Meridian, and of the riſing and ſetting of the Moon, Planet, or Star.

5

Q. How do you repreſent the face of the ſtarry Heaven for a given time?

A. Rectify the Globe, find the Sun's place, bring it to the brazen Meridian, and ſet the Index to twelve hours, then turn the Globe till the Index ſhews the appointed hour and minute, and the ſurface of the Globe will then exactly repreſent the face of the ſtarry Firmament, for the ſame time, at the given Latitude.

6.

Q. How do you find the Altitude of any heavenly body, the Globe being rectified as in the laſt problem?

A. If the given Star be on the Meridian, the degrees and parts between the place where it cuts the brazen Meridian and the Horizon, determine it's altitude, if it is not on the Meridian, ſcrew the Quadrant of Altitude to the Zenith, and bring it's graduated edge to paſs over the given Star, the diſtance, in degrees and parts, from the point where the Star cuts the graduated edge to the Horizon is the altitude required.

Q. How

7

Q. How do you find the Latitude of a place on the terreſtrial Globe?

A. Bring the place to the brazen Meridian, and on it's graduated edge obſerve the number of degrees and parts immediately over the given place, this number, counted from the Æquator, is the Latitude of the place.

8.

Q. How do you find the Longitude of a place?

A. Bring the place to the brazen Meridian, then obſerve what degree and minute of the Æquator is cut by the brazen Meridian; for that is the exact Longitude of the place from the firſt Meridian, and is eaſt or weſt, as the place is eaſt or weſt of the firſt Meridian.

9.

Q. How do you find the difference of Longitude of two places?

A. Bring either place to the brazen Meridian, then obſerve what hour and minute of time the horary Index points to; turn the Globe till the ſecond place is found at the graduated edge of the brazen

brazen Meridian, obſerve again the hour and minute denoted by the index, ſubtract the leaſt from the greateſt, and the difference will be the difference of Longitude of the places in hours and minutes of time; which, converted into degrees, &c. at the rate of 15° to an hour, will give the difference of Longitude in degrees and parts of degrees.

10.

Q. The difference of Longitude being known or found as above, how can you determine the apparent time at any place, when it is noon at the place of obſervation?

A. Turn the difference of Longitude between your Meridian and the place aſſigned into time, this added to, or ſubtracted from noon, according as the place is eaſt or weſt of you, will give the apparent time at the place required when it is noon with you.

11.

Q. How do you find the length of the Twilight, at any place and ſeaſon?

A. Rectify the Globe for the Latitude and Sun's place, ſcrew the Quadrant of Altitude to the Ze-

 nith,

nith, depreſs the Sun beneath the Horizon till the 18th degree on the Quadrant of Altitude, continued below the Horizon, cuts it's centre; obſerve then the hour and minute marked by the horary index: if the index was ſet to twelve when the Sun's centre was brought to the Meridian, the time now ſhewn will be the hour at which twilight ends; and the difference of this and the time ſhewn at Sun-ſet, will be the length of twilight for that place and ſeaſon.

CHAP.

CHAP. VII.

Of the Diviſion of Time.

Q. HOW is Time meaſured?

A. By the apparent motions of the heavenly bodies.

Q. Why is this method of meaſuring time preferred?

A. Becauſe their motions are uniform, conſtant, univerſally obſervable, and eaſily attended to.

Q. Which of the heavenly bodies are principally uſed for this purpoſe?

A. The Sun and Moon; the Sun to meaſure natural days, by it's revolution, from the Horizon or Meridian of any place, to the ſame Horizon, or Meridian, again in twenty-four hours; and the year, by it's apparent courſe through the circle in the Sky, called the Ecliptic.

Q. What are meaſured by the Moon?

A. The ſubdiviſions of the year called Months, they are counted from a conjunction of the Sun and Moon, or new Moon, to the ſucceeding one; they conſiſt of about 29 and one half natural days.

Q. How are ſolar years denominated?

A. Aſtronomic and civil.

Q. What are aſtronomic years?

A. Either the time the Sun takes to move from a tropical point to the ſame again, called a Tropical Year, or a revolution from a ſtar in the Ecliptic to the ſame again, called a Siderial Year.*

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* A tropical year conſiſts of 365 days, 5 hours, and 49′, a ſiderial year of 365 days, 6 hours, 10′. and is longer than a tropical year; becauſe the fixed ſtar remains perfectly at reſt, but the tropical points move a very little backwards; ſo that if at any time a fixed ſtar was found to coincide with the tropical point, at the inſtant the ſun was at that tropic in the courſe of a year, the tropical point would be found a little behind the ſtar, and therefore the ſun would arrive at it before he returned to the ſtar, though he left both at the ſame moment of time; therefore the tropical is ſhorter than the ſiderial year.

Q. What is a civil year?

A. A computation of time founded on the aſtronomic year, calculated to ſerve the purpoſes of ſociety.

Q. Does any aſtronomic year preciſely anſwer for the civil reckoning?

A. No; becauſe no number of exact days make an aſtronomic year.

Q. How then has the civil year been determined?

A. Julius Cæſar, in regulating the Roman calendar, made it to conſiſt of 365 days, 6 hours, and omitting the ſix hours for three ſucceſſive years, at the end of each fourth made uſe of an additional day to account for them, and, from the name of the additional day, this fourth year was called Biſſextile.*

Q. Of what uſe in common life was it, to introduce every fourth year an additional, or intercalary day?

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* Biſſextile from *bis*, twice, and *ſextilis*, or the ſixth of the calends of March, the name of the day twice taken in that year.

A. It was deſigned by this expedient, to bring the ſame ſeaſons in every returning year to months and days of the ſame names; which would add much to eaſe and convenience.

Q. Did the Julian contrivance accompliſh this purpoſe?

A. No; for as it made the civil year about eleven minutes longer than the tropical aſtronomic year, this ſmall difference in a number of years amounting to days, made the ſeaſons return on earlier days than at the original fixing of the Julian year.

Q. Has this irregularity been rectified?

A. Yes. Pope Gregory, about the end of the ſixteenth century, corrected the growing error of the Julian ſtile.

Q. How did he effect this correction?

A. By dropping at once ten days, and, as the Julian error gains about three days in four hundred years, he prevented it's growing again, by directing, that whereas in the old ſtile every hundredth year was a Biſſextile in the new one, three out of four ſhould count as common years.

Q. When was the Gregorian, or New Stile, adopted in the Britiſh dominions? *A.* In

A. In the year 1752, when the Gregorian correction requiring a day more than when it was originally introduced, eleven days were at once dropped; and thus our dates were made to correſpond with thoſe of all the other civilized nations of Europe, Ruſſia only excepted.

Q. How came a Pope to interfere in this buſineſs?

A. To bring back the feſtivals of the church to the exact days on which they were appointed to be celebrated, at a general council of the church held at Nice in the year of Chriſt 325.

Q. What are meant by Epochs or Æras?

A. Remarkable times from which dates are numbered.

Q. Which are the chief of theſe?

A. The creation of the world, the deluge, the olympiads, or the commencement of the inſtitution of the olympic games in Greece, the building of the city of Rome, the birth of Chriſt, and the Hegira among the Mahometans.

Q. What is the Equation of Time?

A. A correction to be applied to the apparent time of the day, as deduced immediately from the Sun, either by the ſhadow on the dial, or from his appulſe to the Meridian, for the purpoſe of regulating watches or clocks.

Q. Whence ariſes the neceſſity for this correction?

A. It ariſes from hence, that clocks and watches are intended, by their conſtruction, to move equally and regularly, and the Sun's apparent motions, to which they are referred, are irregular and unequal.

Q. What follows from hence?

A. That the natural day of twenty-four hours, as ſhewn by a revolution of the Sun from any meridian to the ſame again, being at ſometimes a longer and at others a ſhorter portion of time, cannot always correſpond with the natural day of twenty-four hours, as ſhewn by the clock, which is an equal and invariable meaſure of time.

Q. How then is the clock ſaid to move in ſolar time?

A. Becauſe, if duly regulated by the Sun, the

clock

clock ſhews the exact length of the natural day, as meaſured by the Sun when moving at his mean rate between his quickeſt and ſloweſt apparent motion.

Q. What is this time called?

A. Mean Solar Time.

Q. What is the time as immediately deduced from the ſhadow on the dial called?

A. Apparent, or ſometimes, true time.

Q. What is the greateſt daily difference between mean and true time?

A. About 30″.

Q. To how much does the Equation of Time amount when the required correction is greateſt?

A. To about 16′, being the accumulation of the daily differences, till they begin to take a contrary direction, or till the Sun, from having moved either quicker or ſlower than his mean rate, comes to move at that preciſe rate.*

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* The explanation of the aſtronomical cauſes, on which the equation of time depends, requires a more extenſive acquaintance with that ſcience than this little tract profeſſes to communicate.

OF THE

CALENDAR.

Q. WHAT is meant by the word Calendar?

A. A regular printed ſeries of the days, weeks, and months of the year, diſpoſed in their proper order, and diſtinguiſhing the more remarkable days eccleſiaſtical and civil.

Q. Whence is the name derived?

A. From the Greek word Kalends, which gave it's name to a principal diviſion of the Roman month.

Q. What

Q. What is the uſe of the civil Calendar?

A. To mark the days appointed for the more important purpoſes of civil life.

Q. What is the intent of the eccleſiaſtical?

A. To determine the due celebration of the days of feſtivity, or abſtinence, appointed by the church, called the Sundays and holidays of the year.

Q. How are theſe holidays divided?

A. Into moveable and immoveable.

Q. Which are the immoveable?

A. Thoſe which are annually obſerved on the ſame days of the ſame months.

Q. Which are the moveable?

A. Thoſe which depend on the time, or day, of the celebration of Eaſter-day.

Q. How comes Eaſter-day to be a moveable feaſt?

A. Becauſe it's obſervance depends on the day of the firſt full moon that happens on or after the twenty-firſt of March; and as the full moons of following years never happen on the ſame days of the months as in the immediately preceding ones,

Eaſter-

Eaſter-day cannot happen on the ſame day of the month in two ſucceeding years.

Q. How are you inſtructed to find the days of the months on which the moveable feaſts will happen in each year by the Calendar.

A. By means of certain aſtronomical notes and numbers calculated for the purpoſe, and annexed in their reſpective tables to the Calendar.

Q. Which are the principal of theſe numbers and notes?

A. The Golden Number, the Sunday Letter and the Epach.

Q. What is the Golden number of any year?

A. It is one of the nineteen numerals that belong in their order to the nineteen years that bring round the period of the Lunar irregularities of motion; at the end of which period the new and full moons will again happen on the ſame days of the months of the ſolar tropical year, and nearly at the ſame hour as they did at the commencement of the former ones.

A. From whom have we derived this Lunar Cycle?

A. From

A. From the Chaldeans, who called it the Saros, and gave it to the Athenians, who having cauſed it to be inſcribed on a public Edifice at Athens, in gold characters, it thence obtained the name of the Golden Number.

Q. What is the Sunday Letter of any year?

A. It is one of the Seven Letters, annexed in their alphabetical order to the days of the month (beginning with the letter A for the firſt of January) which falls on each Sunday of the year it belongs to.

Q. Which are the Sunday Letters?

A. A, B, C, D, E, F, G.

Q. In what order do theſe Letters recur?

A. In common years the preceding Letter to the Sunday Letter of any given year will be the Sunday Letter of the next year.

Q. Explain this ſucceſſion.

A. Suppoſe A to be the Sunday Letter of any year, as A marks the firſt of January, and alſo a Sunday, it is manifeſt the year began on a Sunday, but the common year ends on the ſame day on which it began; i. e. on Sunday, therefore the next year begins on Monday; A therefore denoting January

uary 1. and Monday, is the Monday Letter of the year, B the Tueſday, C the Wedneſday, D the Thurſday, E the Friday, F the Saturday, and G the preceding Letter to A. the Sunday Letter for the year.

Q. Is this ſucceſſion ever interrupted?

A. It is—by the Leap years, which have two Sunday Letters; one before the intercalary day in the uſual order, and the preceding Letter to this for the remainder of the year.

Q. What is the reaſon of this order?

A. Becauſe the ordinary Letter of the twenty-eighth of February is repeated for the intercalary day.

Q. According to this interrupted order, when will the ſame ſucceſſion of Sunday Letters recur?

A. In twenty-eight years, making what is called Cycle.

Q. What is meant by the Epact?

A. It is a number denoting the moon's age at the beginning of the Solar Tropical Year.

Q. Whence is this Number deduced?

A. From the conſideration that the Tropical yea

exceed

exceeds the Lunar year of twelve Lunar months, by eleven days.

Q. If then the Solar year begins on the day of New Moon, what will be the Epact of that year?

A. O, or Zero.

Q. What will be the Epact of the ſucceeding year?

A. Eleven days of the next twenty-two, of the following three, as between the two laſt thirty days are dropped, they forming an entire intercalary month.

THE END.

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DIMENSIONS of the SOLAR SYSTEM

in round numbers.

Mean ☉ D of ☉ in English Miles 3985.

Distances of Planets from the Sun.

☿	36 M of M
♀	68 M of M
⊕	95 M of M
♂	144 M of M
♃	493 M of M
♄	904 M of M
♅	1800 M of M

Apparent diameters at the mean distance of the Earth from ☉			Diameters compared with the Earths.		Bulks in round Numbers.	
☉	32′	2″	☉	107	☉	12000 Earths
☿		7	☿ ×	1/3	☽	1/49 of an Earth
♀		17	♀	1	☿	1/7 of an Earth
⊕		18	⊕	1	♀ ×	4/5 of an Earth
☽		5	☽	1/3	♂	1/4 of an Earth
♂		11½	♂	5/8	♃	1246 to 1
♃	3	14	♃	11	♄	868 to 1
♄	2	52	♄	9½	♅	
♄ ○	6	41	○ ♄	22		

Diurnal revolutions				Annual revolutions			Earths Satellite ☽
	d	h	′				
☉	25	6	0	☿	3	Months	Greatest distance 64 36
☿				♀	8	Months	5 diameters of the Earth
♀	#24	or 23	0	⊕	1	Year	
⊕		23	56	♂	2	Years	Least distance 55 5/6
♂		24	40	♃	12	Years	5 Diameters
♃		9	56	♄	30	Years	Periodical Month
♄				♅	93	Years	d 27 h 7 ′ 43
♅							Synodical Month
							d 29 h 12 ′ 44